MAYFLOWER PROJECT

WASATCH COUNTY, UTAH

Mine Tailings

WORK PLAN

for the

Hydrogeologic/Geochemical & Geotechnical Studies

Prepared by:

Bingham Engineering
5160 Wiley Post Way
Salt Lake City, Utah
USA

&

Delft Geotechnics
Stieltjesweg 2
Postbus 69, 2600 AB Delft
Holland

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for the
Hydrogeologic/Geochemical & Geotechnical Studies

June 1987

BO-289160/31

PRINCIPAL:

May Finance,
Stichting Beheer Mayflower-project,
Leerdam,
The Netherlands.

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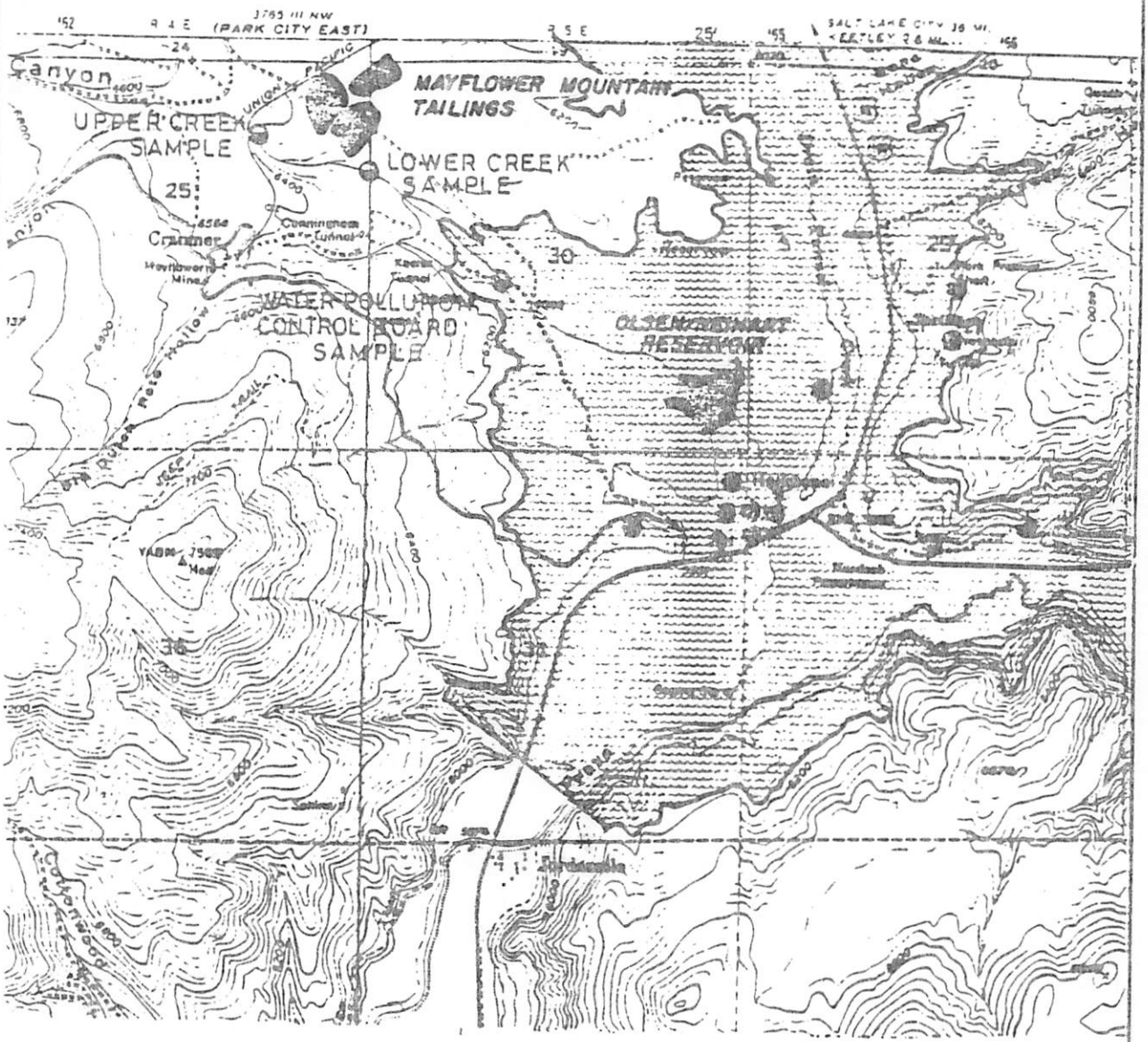

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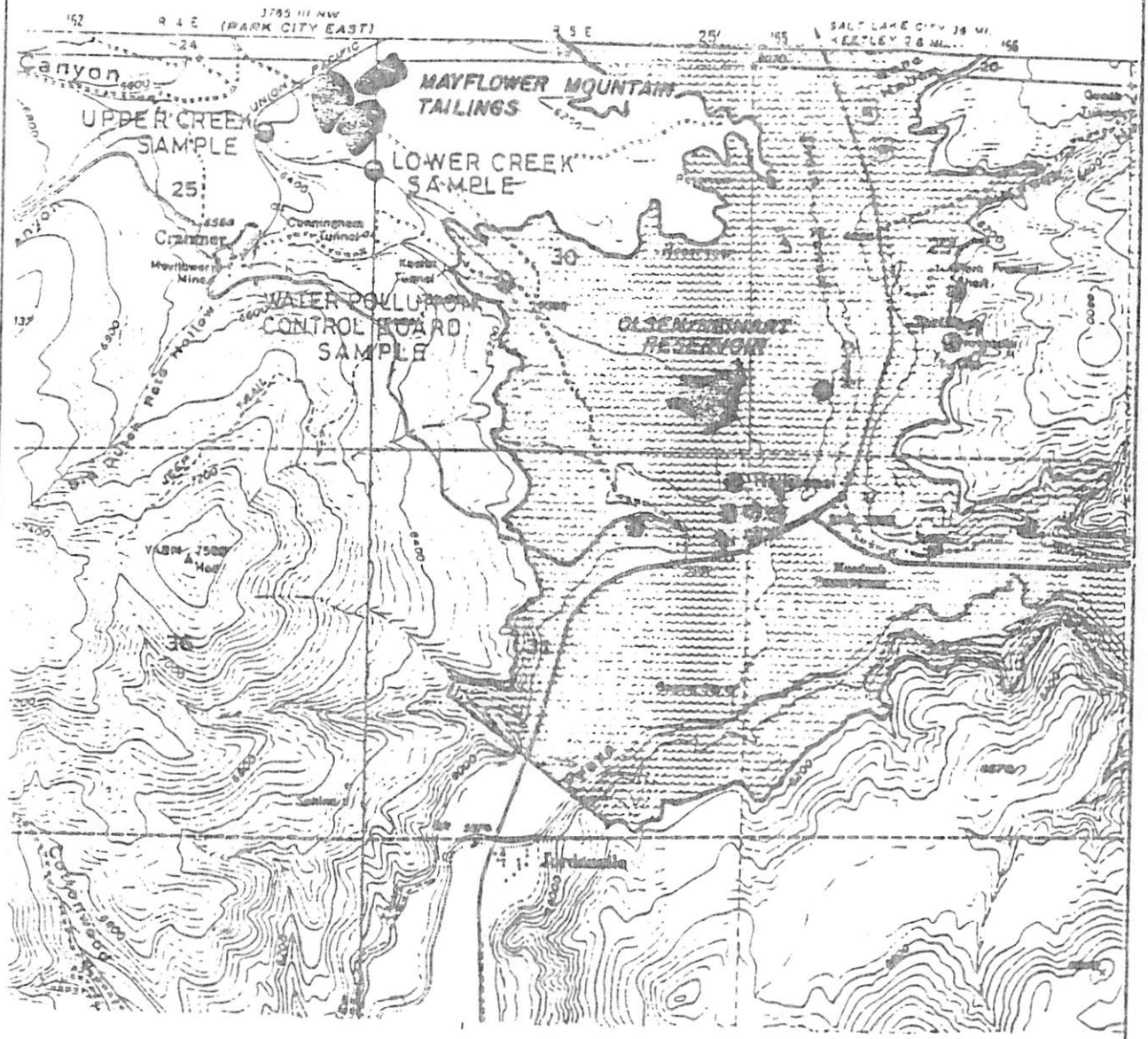

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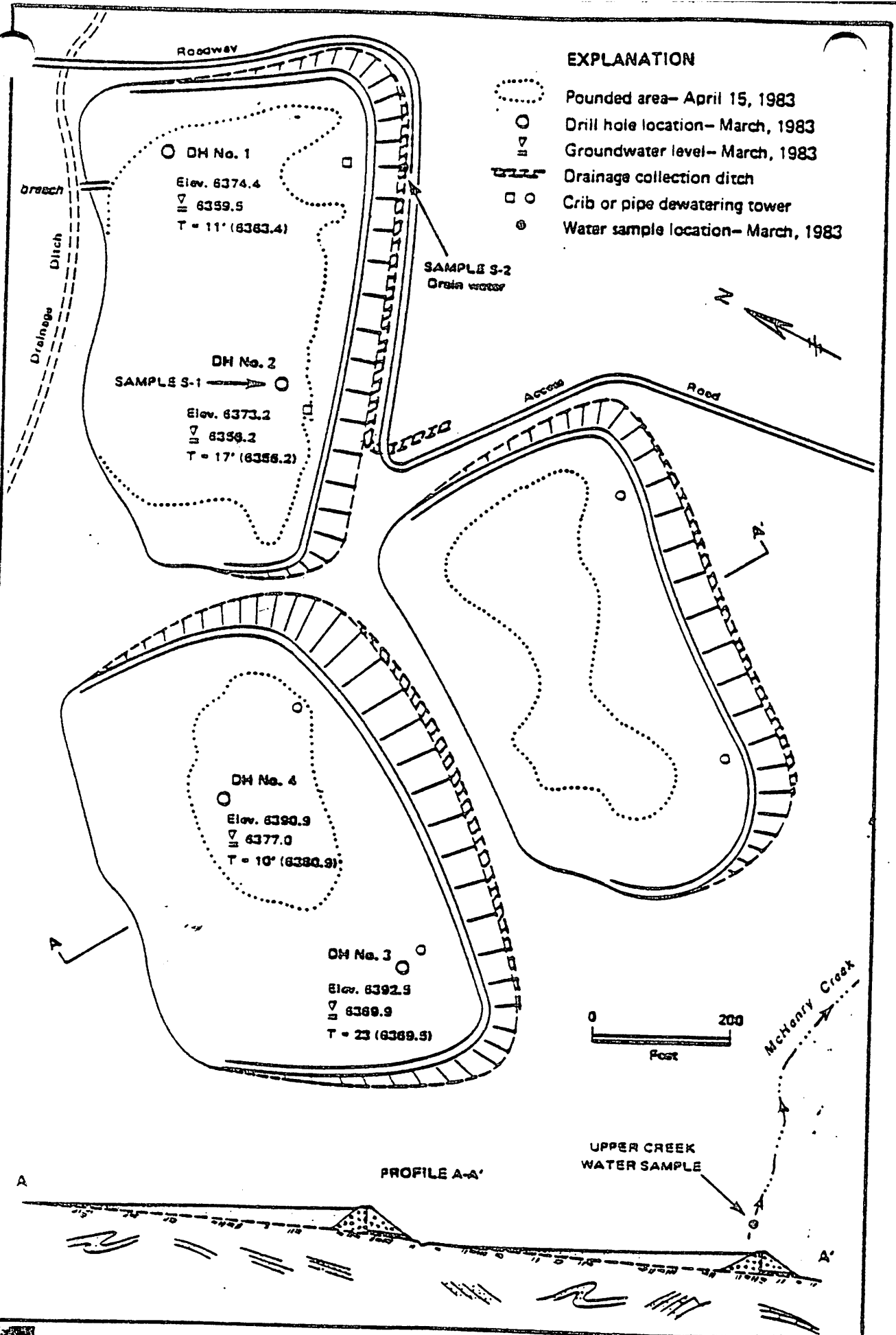

DELFT GEOTECHNICS	P.O. Box 69, 2600 AB Delft Holland phone (015) - 569223 Holland	Telefax (0)15 61 09 21 Telex 38234 soil nl	Date 1987 - 03
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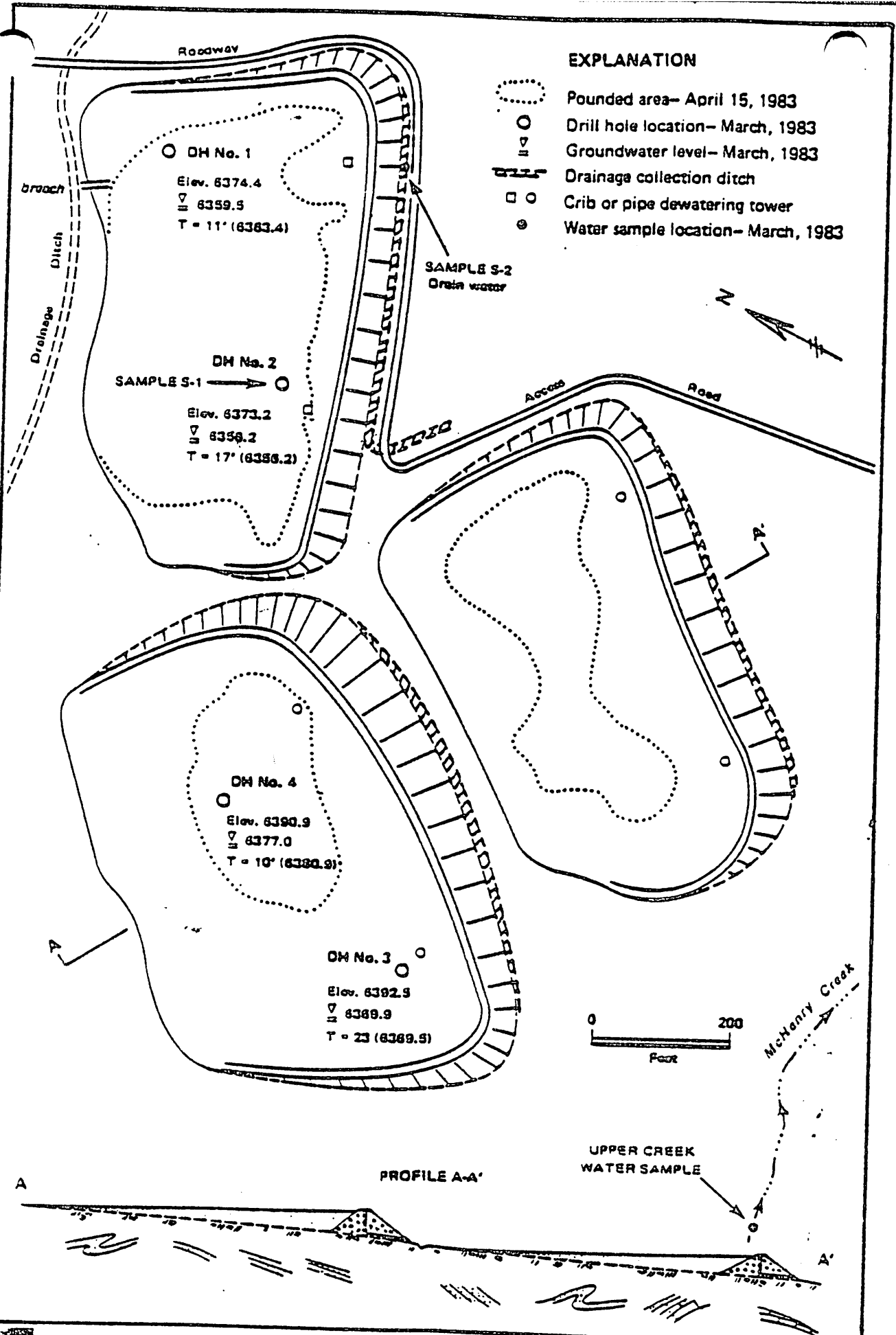
PLOT PLAN AND PROFILE MAYFLOWER TAILINGS PONDS			



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PLOT PLAN [illegible] MAYFLOWER TAILINGS PONDS

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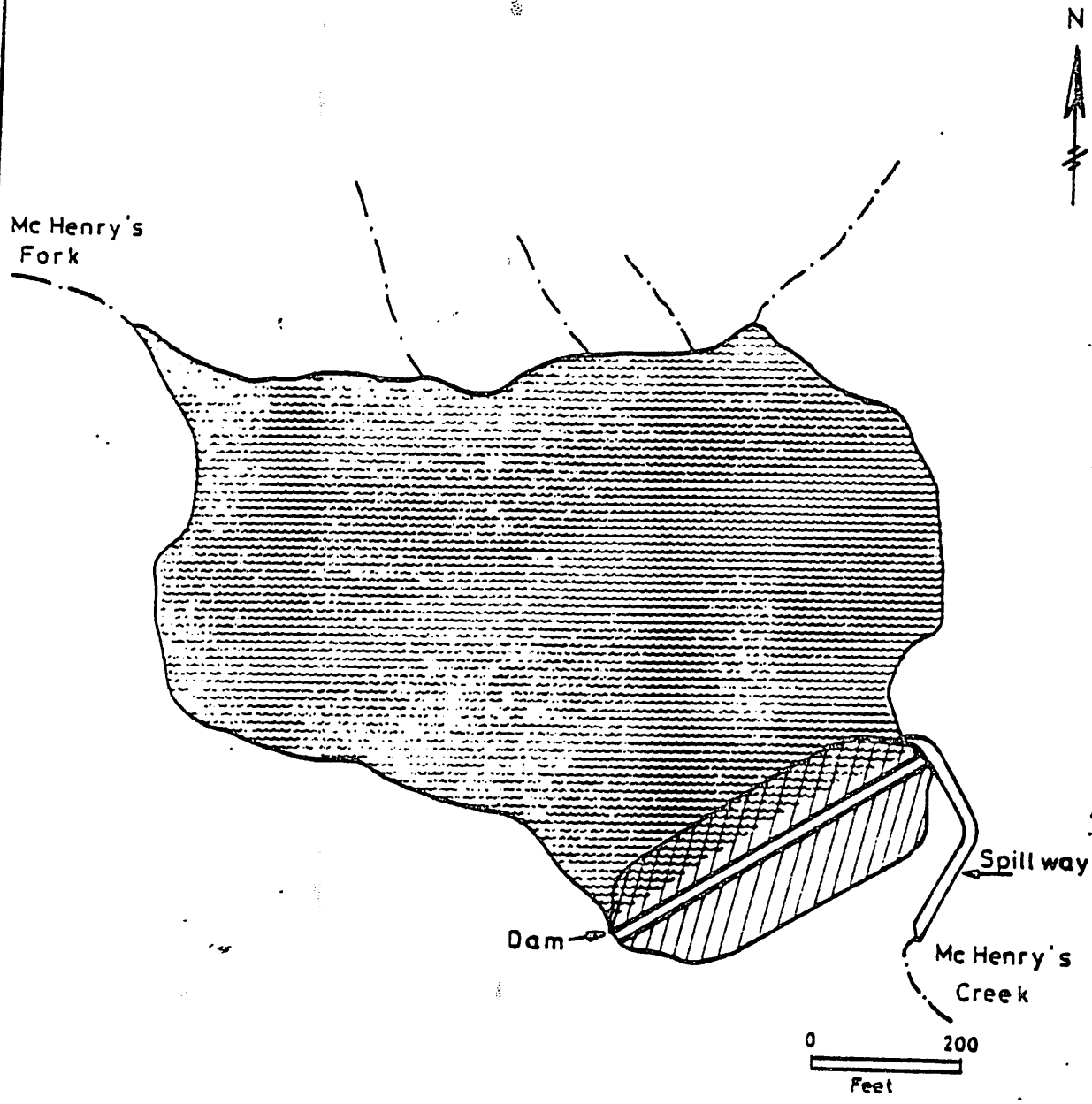

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MAYFLOWER PROJECT

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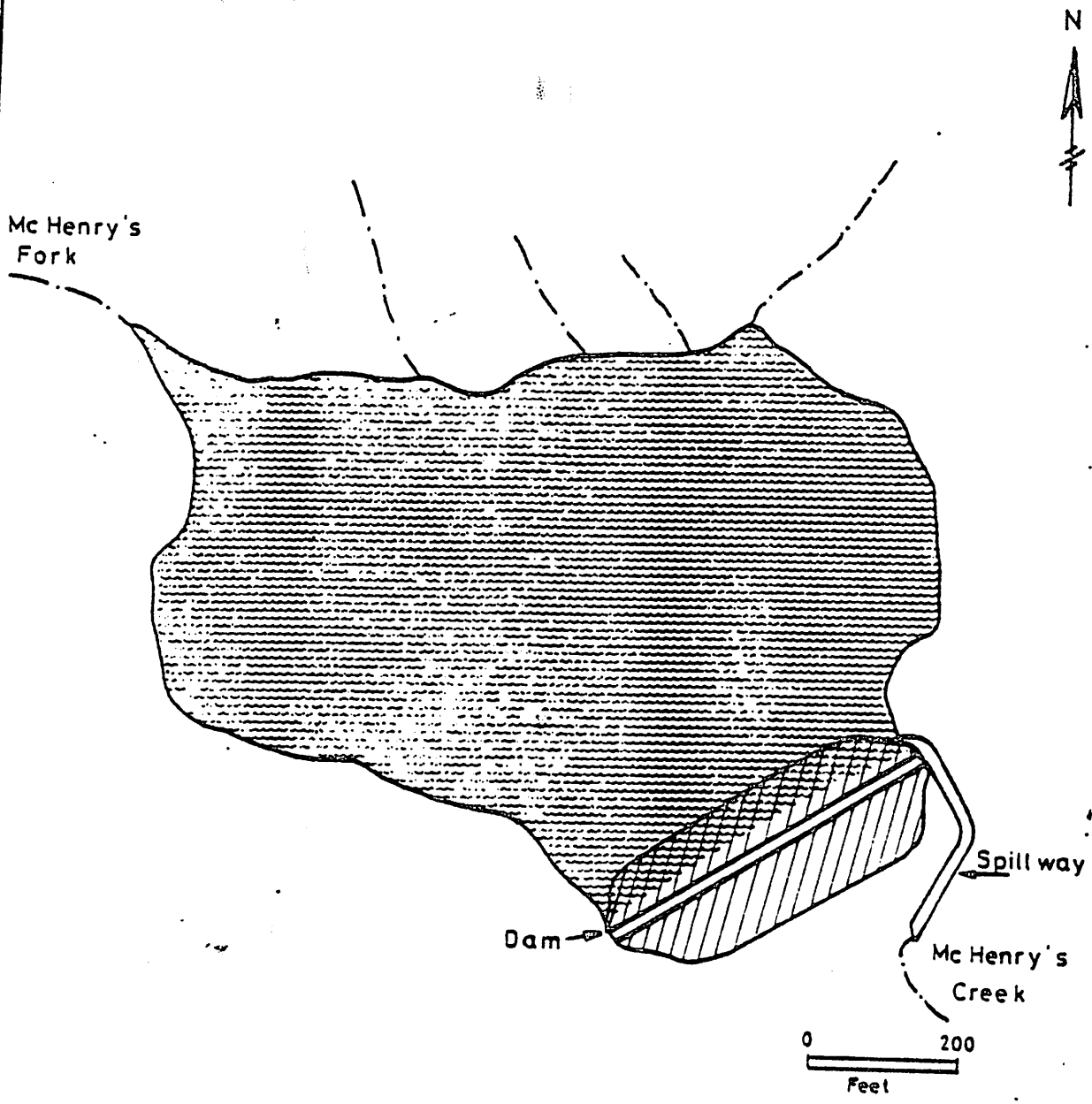
PLOT PLAN DESENGANO RESERVOIR



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date 1987 - 03

MAYFLOWER PROJECT

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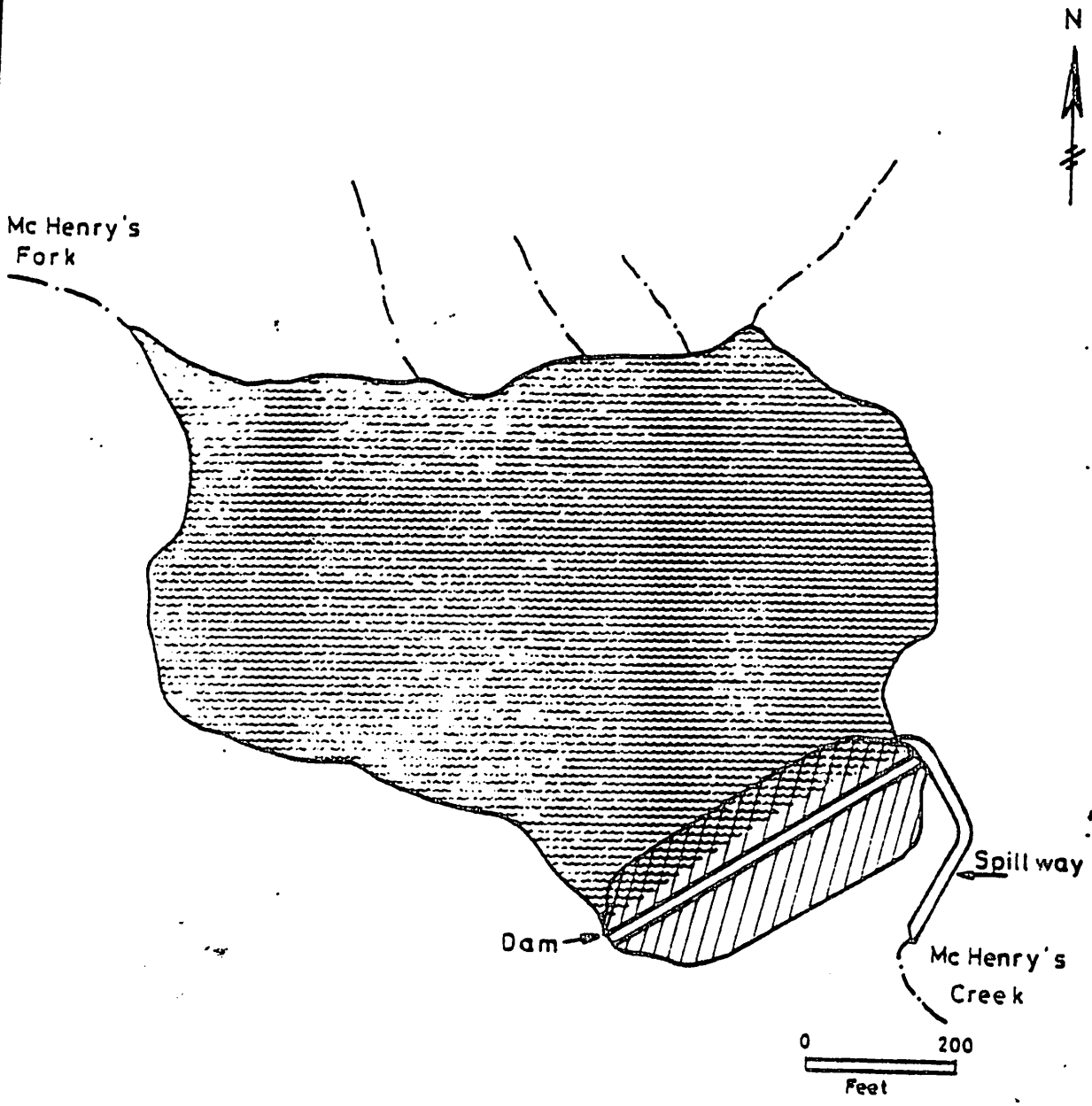
PLOT PLAN OLSEN-WEIHART RESERVOIR



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GEOTECHNICS
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PLOT PLAN OLSEN

REMARK on drilling:
An important objective of drilling is to identify important and characteristic layers (e.g. contaminants, aquifers and aquitards). In order to determine the required drilling and piezometer depths on the different locations, drilling should preferably proceed as follows:

MAYFLOWER SITE:
- first a deep (exploration) hole is to be drilled down stream of the MF Ponds. This is intended to define the full soil spectrum in the area, to disclose the geologic characteristics, identify the relevant aquifers and the water table depth. This hole was completed in April 1987.
- next all holes adjacent to the tailings can be drilled.
- finally drilling should be performed in the tailings, sampling and piezometer depths should be set by taking into account the information obtained on the previous borings. Continous sampling will be performed in the tailings to identify the permeability and depositional characteristics.

OLSON NEIHART SITE:
- drilling is to proceed through the tailings and a minimum of ten feet into native soil. Continous sampling will be performed in the tailings to identify depositional characteristics and changes in composition of the tailings.

filtered on site over a 0.45 µm membrane filter. After filtration some samples should be prepared with nitric acid to pH = 2.

REMARK on analysis:
On the basis of existing information constituents have been selected as potential problem candidates. In order to establish a detailed picture of the migration of the contaminants all selected soil and water samples will be analysed for the constituents listed in table 9. Constituents can be devided in groups, the constituents in table 9 are listed under Drinking Water Trace Elements [Everett, 1980]. This list also includes constituents we excluded: Chromium (Hex), Cyanide and Selenium. Specific requirements of the laboratory analysis are provided in Annex 3.

In the current database there are a number of analyses of contaminants which do not indicate major problems. However, for completeness some soil and water samples will be analysed for the contaminants listed in table 10:

TABLE 10: other constituents.

Aluminium	Boron
Gold	Magnesium
Mercury	Molybdenum
Nickel	Phenol
Selenium	Strontium

To estimate the potential migration of contaminants it is of importance to be able to estimate the pore water concentrations of key components. It is also necessary to establish the adsorption behaviour of these on the native soil and thus to determine the distribution coefficients for the contaminants under consideration. The components listed in table 11 are to be analysed to facilitate this estimation.

TABLE 11: additional analysis.

Ammonia	Calsium
Carbonate	Chloride
Organic carbon	Potassium
Phosphate	Redox potential
Sodium	Sulphate
Sulphide	Sulphur total
Total alkalinity	Total Hardness

Stability analyses will be based upon field and laboratory data developed as part of this plan.

Settlement

Results of the testing program will also be used to asses settlement of the tailing, foundation and embankment soils based on the different design alternatives. The settlement analyses will aid in selecting proper reclamation method(s) based on site development requirements. It is anticipated that some form of tailing densification will be required as part of the reclamation activities.

Construction Methods and Alternatives

The engineering analyses will also include evaluating various construction methods to determine the most feasible, cost effective approaches. This will include evaluating whether to use on-site or imported fill materials as construction materials.

3.2.5 Conceptual Design

Conceptual designs will be developed for the preferred reclamation alternatives. The conceptual designs will be developed using the stability, settlement and constructability results. These designs will be used to develop estimates of reclamation costs and schedules.

3.2.6 Cost Estimates For Alternatives

As discussed, several design alternatives are being considered which will be acceptable to the control and retention of the tailing material and fit in with the overall Mayflower development master plan. Obviously there are minimum design requirements which must be met to comply with the State and Federal regulations. Each of the alternatives will be broken down into the purpose for the option and the cost. The costs will be developed using appropriate equipment and personnel rates based the latest publications. All aspects of construction will be taken into account such as access and availability of on-site borrow versus imported material.

3.2.7 Summary Report

A summary report will be prepared to provided all concerned parties with a summary of geotechnical data collected during this study and a listing of associated design requirements. The report will include the results of all field and laboratory investigations with logs and testing summaries. Results of all analytical efforts such as stability analysis and other technical information used in design will also be provided. A section of the report will be a description of the various options and the associated costs and benefits to the overall project.

4. PROJECT SCHEDULE AND PROGRESS REPORTS.

Project schedule

The project schedule is presented as Figure D. This schedule is based on sequencing all of the phases so that some of the materials testing and other analysis can begin while the field program is still going on. The results of tests will be forwarded to the appropriate agencies and owners at least monthly. The scheduling is subject to minor changes however, there are certain items which must follow a critical path and be completed very close to the schedule provided. Once the project is authorized the schedule will be revised to include dates. Copies of the schedule will be sent to all involved parties.

Monthly progress reports

Monthly progress reports will be generated throughout the study. In general, the following project monitoring, control and review activities should be reported on:

- Review of technical status and progress.
- Health and safety-related operational planning, review and audits.
- Maintenance of documentation and document control.
- Coordination of contract with other affected agencies and parties
- Contract and subcontract administration.
- Quality assurance and quality control.

Technical Program Reports.

As indicated above each of the tasks 1 through 4 will be reported on completion. Sub-tasks where review and comment is essential (for example, task 4.5) will be reported separately to facilitate this review.

Draft Final Report.

A preliminary report will be prepared upon completion of the site geohydrological characterization. The preliminary report will contain a summary and analysis utilizing both the data in existence at the beginning of the and new data developed during the investigation. The report for the MF site will address the environmental impacts and public health risks emanating from the developed site, including: (1) surface water contamination, (2) contaminated ground water, (3) presence of tailings onsite, (4) presence of tailings offsite, (5) contaminated soils or sediments, (6) potentially contaminated ground water supplies, and (7) potential of air quality degradation due to wind-blown tailings.

Final Report.

At the conclusion of the draft report review and comment process, appropriate changes will be incorporated, and a final report will be prepared.

5. PROJECT MANAGEMENT AND QUALITY ASSURANCE.

5.1 Project Team

The majority of the tasks will be performed by personnel from Bingham Engineering and Delft. Bingham Engineering will be responsible for executing all field and laboratory activities and all geotechnical engineering related office studies. Delft will be responsible for the hydrogeological and geochemical studies.

The proposed organizational chart, which is shown on Figure C, indicates the roles of key personnel. The project team of Bingham Engineering will consist of a project manager who will have control over all aspects of the field and laboratory programs. His responsibilities will also include coordination and transfer of all pertinent data to Delft for use in their interpretation. Bingham Engineering personnel are experienced in the drilling, logging and sampling of exploration holes, the completion of monitor wells, groundwater sampling and laboratory analysis. Bingham Engineering will subcontract the drilling and backhoe work and the chemical analysis testing.

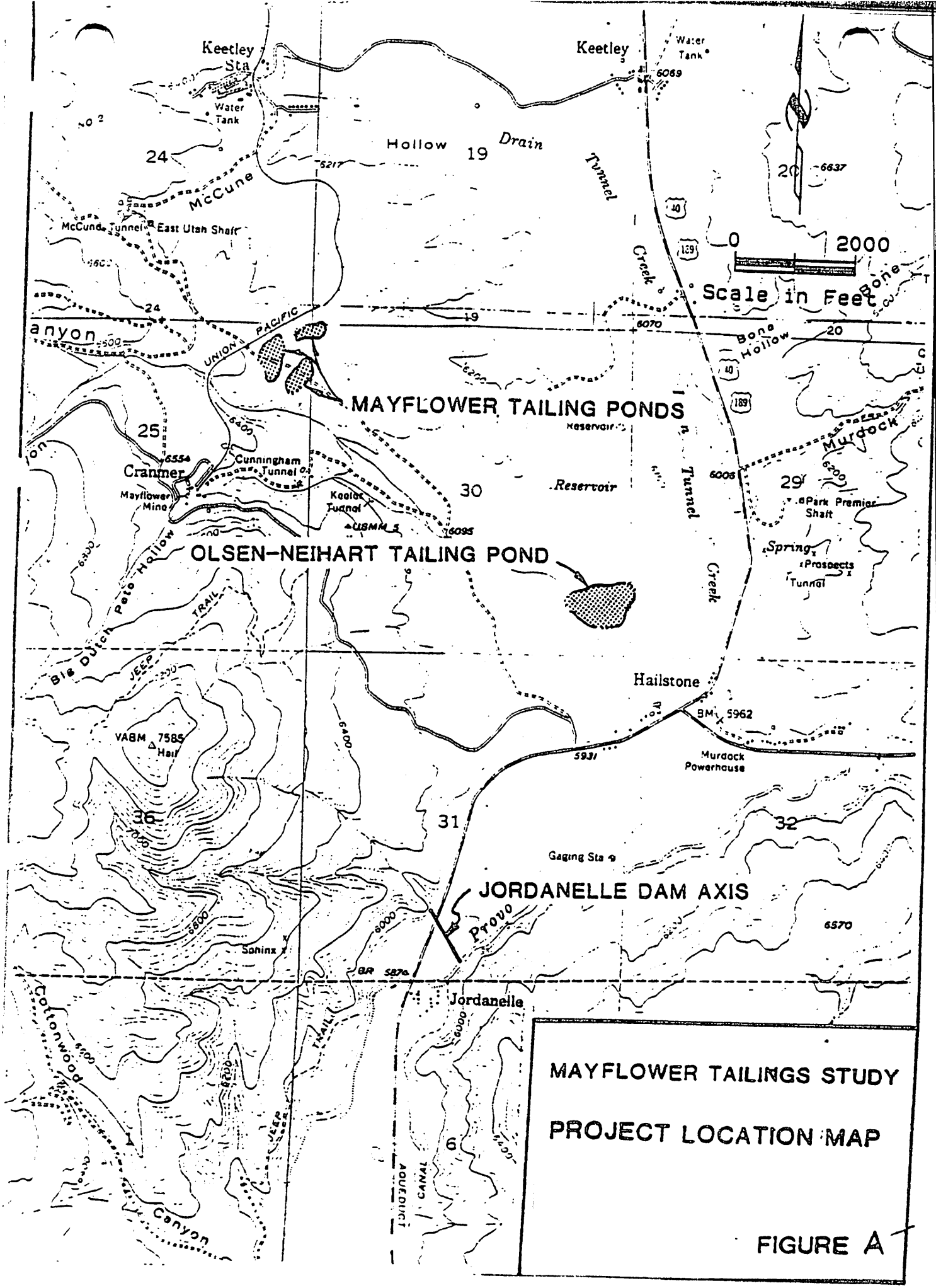
5.2 Quality Assurance Project Plan (QAPP)

A quality assurance plan has been developed and is included here as Annex A. This plan will be carefully followed throughout the project to assure compliance with all pertinent requirements.

The quality assurance program associated with the computer and modeling exercise will be established to the States satisfaction and could include artificial bench-mark calculations of known outcome, or source statement review. The Delft Geotechnics is to make such a review possible and the data base accessible.

5.3 Health and Safety Plan (HASP)

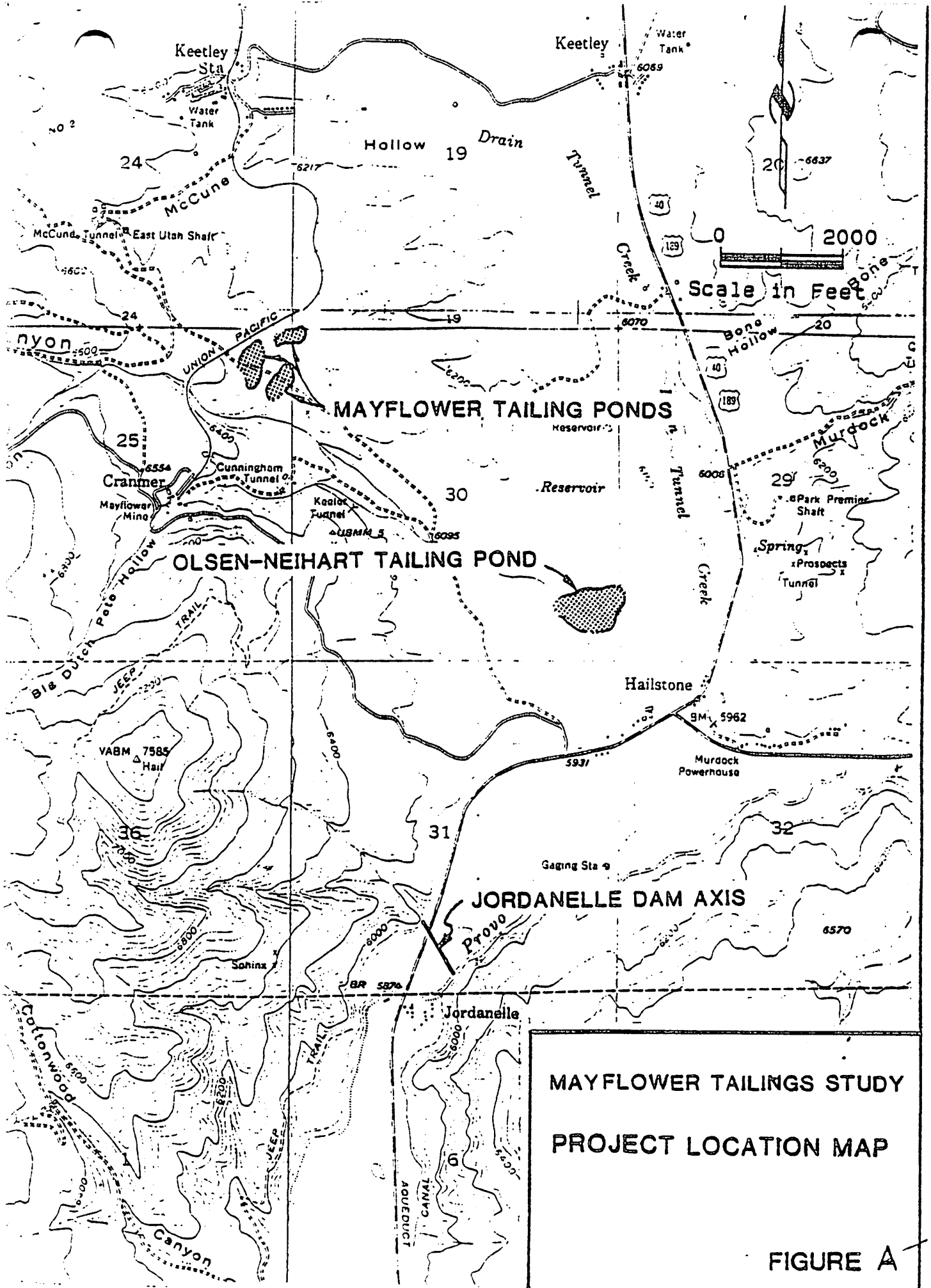
An approved health and safety plan will be incorporated into the program which will include all pertinent requirements and monitoring to assure compliance with federal and state procedures. This is provided in Annex B of this work plan.



MAYFLOWER TAILINGS STUDY

PROJECT LOCATION MAP

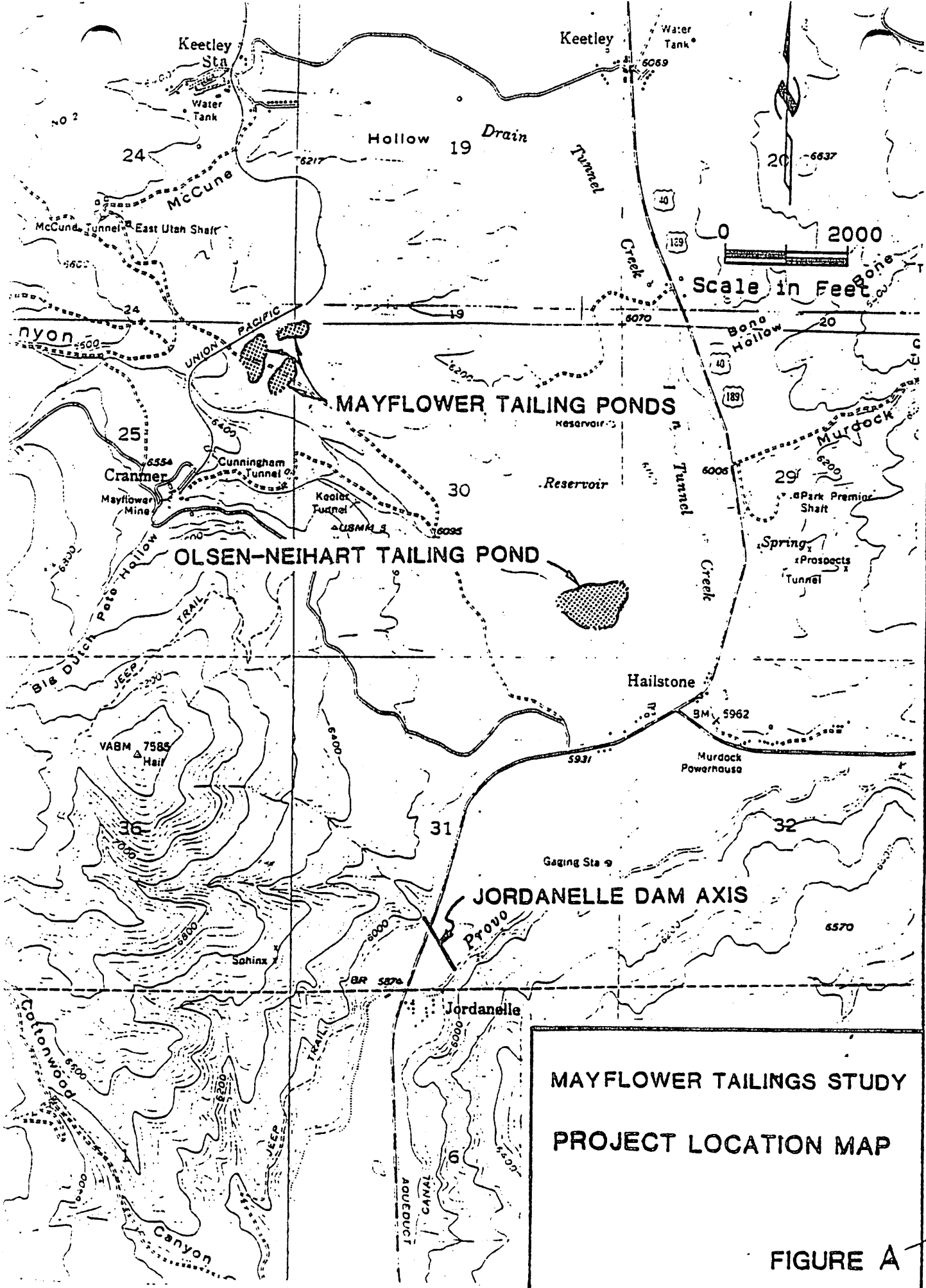
FIGURE A

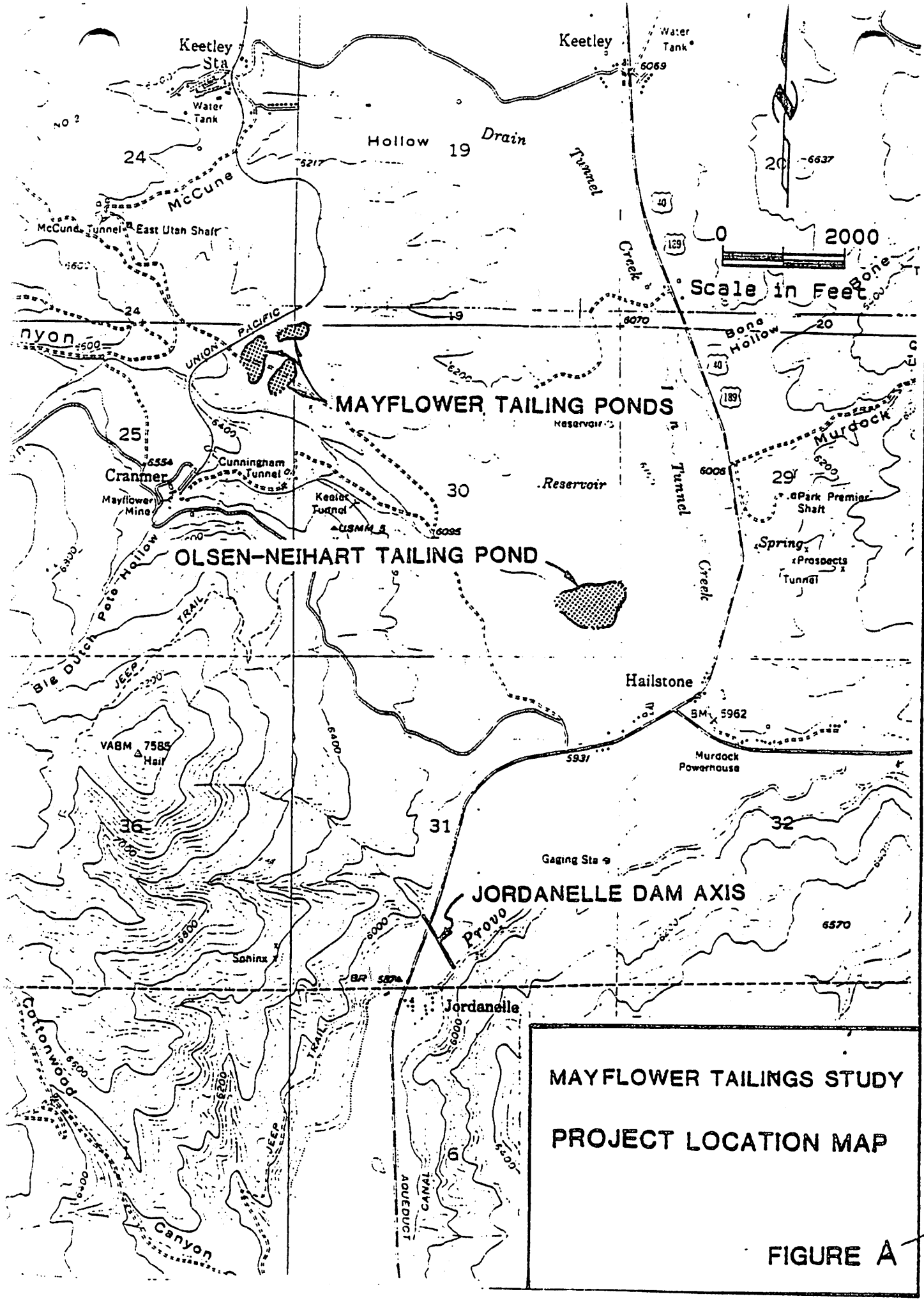


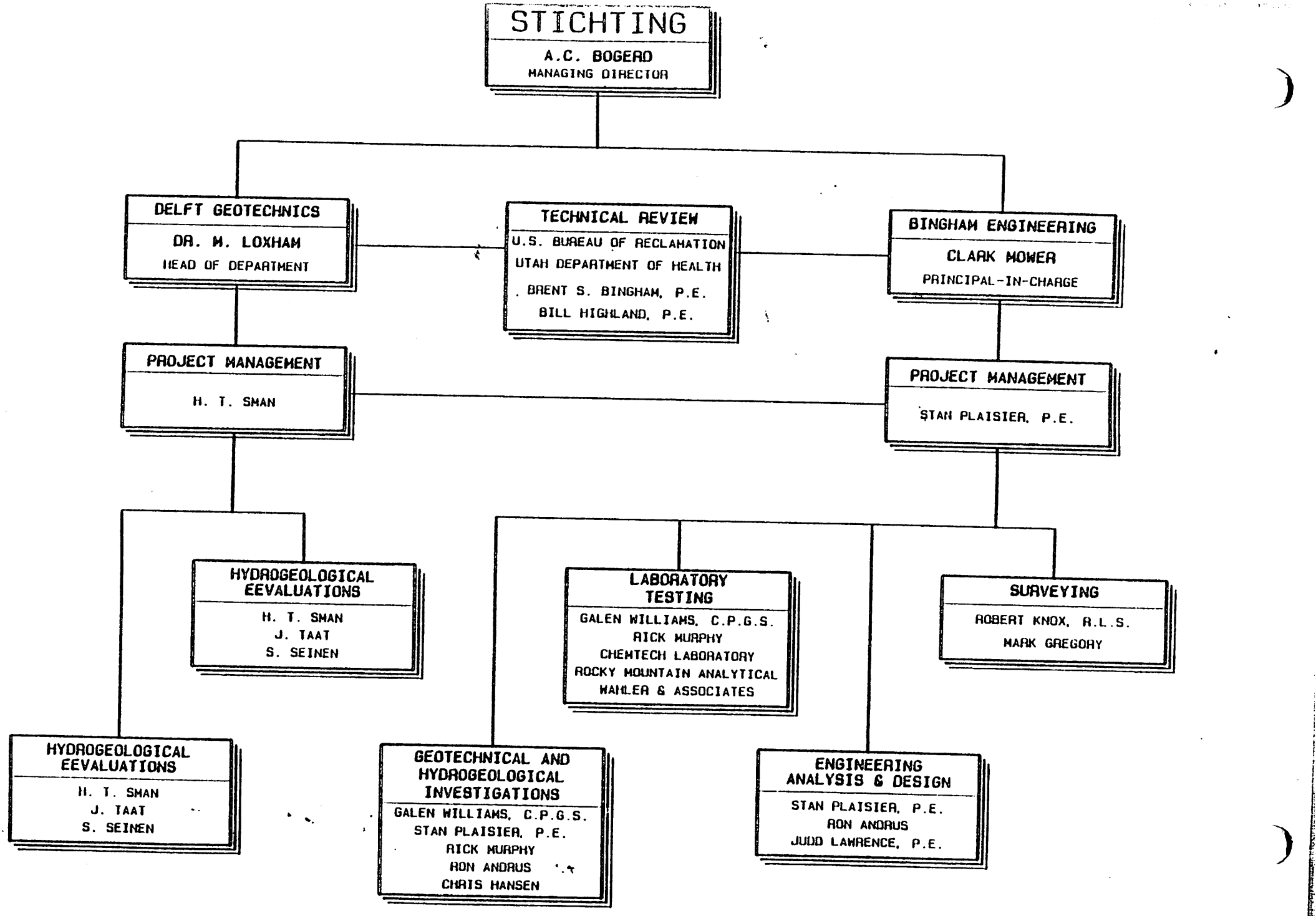
MAYFLOWER TAILINGS STUDY

PROJECT LOCATION MAP

FIGURE A


MAYFLOWER TAILING PONDS
OLSEN-NEIHART TAILING POND
JORDANELLE DAM AXIS
Keetley Sta
Keetley
Water Tank
Hollow
Drain
Tunnel
McCune
McCune Tunnel
East Utah Shaft
Scale in Feet
0
2000
UNION PACIFIC
Bone Hollow
Reservoir
Cunningham Tunnel
Cranmer
Mayflower Mine
Keeler Tunnel
Murdock
Park Premier Shaft
Spring
Prospects
Tunnel
Creek
Big Dutch Polo Hollow
TRAIL
JEEP
Hailstone
Murdock Powerhouse
Gaging Sta
Provo
Sphinx
Jordanelle
Cottonwood
Canyon
AQUEDUCT
CANAL
MAYFLOWER TAILINGS STUDY
PROJECT LOCATION MAP
FIGURE A


Keetley Sta
Keetley
Water Tank
Water Tank
6069
Hollow
Drain
19
20
6637
24
5217
McCune
McCune Tunnel
East Utah Shaft
Tunnel
Creek
0
2000
Scale in Feet
Bone
Bone Hollow
PACIFIC
UNION
MAYFLOWER TAILING PONDS
Reservoir
6070
25
6554
Cranmer
Cunningham Tunnel
Mayflower Mine
30
Reservoir
Keelar Tunnel
USMM 5
6095
Murdock
6006
29
Park Premier Shaft
Spring
Prospects
Tunnel
OLSEN-NEIHART TAILING POND
Big Dutch Pete Hollow
TRAIL
JEEP
Hailstone
BM 5962
5931
Murdock Powerhouse
VABM 7585
Hail
36
31
32
Gaging Sta
JORDANELLE DAM AXIS
Provo
6570
Soninx
BR 5874
Jordanelle
Cottonwood
Canyon
TRAIL
JEEP
AQUEDUCT
TUNNEL
6
MAYFLOWER TAILINGS STUDY
PROJECT LOCATION MAP
FIGURE A



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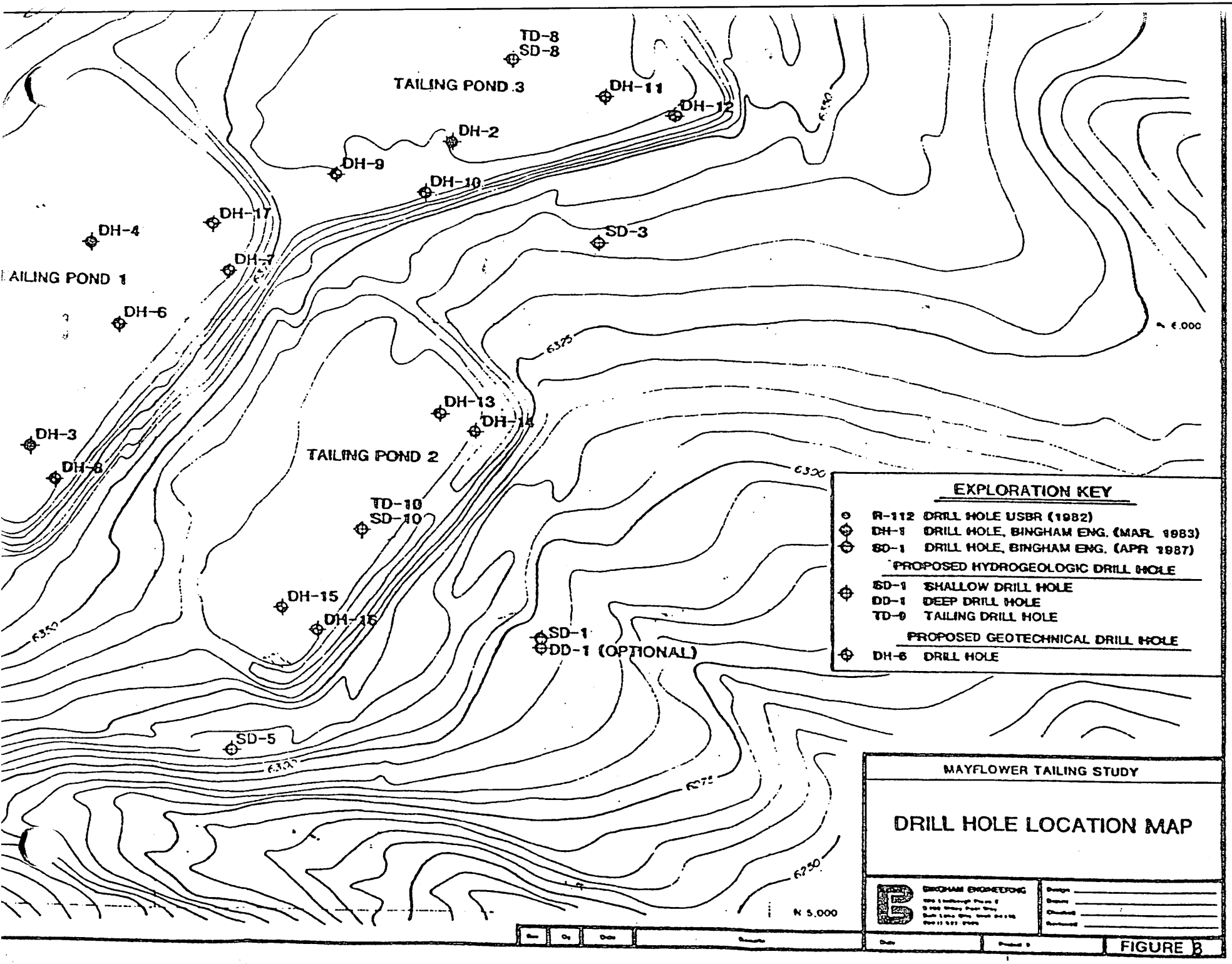
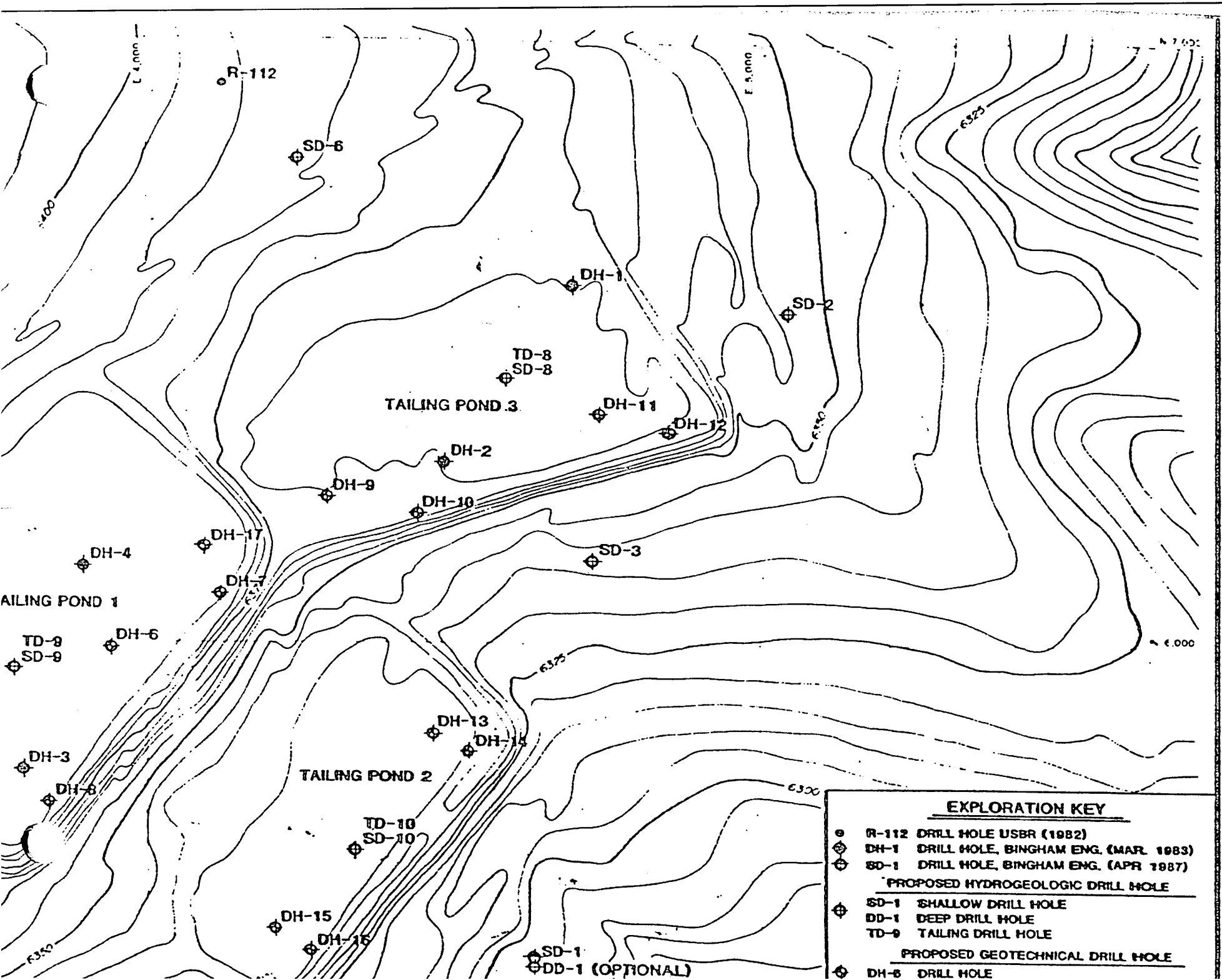

TD-8
SD-8
TAILING POND 3
DH-11
DH-12
DH-2
DH-9
DH-10
DH-17
DH-4
SD-3
DH-7
AILING POND 1
DH-6
6,000
6350
DH-13
DH-14
DH-3
TAILING POND 2
DH-8
6300
TD-10
SD-10
DH-15
DH-16
6350
SD-1
DD-1 (OPTIONAL)
SD-5
6300
6275
6250
N 5,000
EXPLORATION KEY
R-112 DRILL HOLE USBR (1982)
DH-1 DRILL HOLE, BINGHAM ENG. (MAR. 1983)
SD-1 DRILL HOLE, BINGHAM ENG. (APR 1987)
PROPOSED HYDROGEOLOGIC DRILL HOLE
SD-1 SHALLOW DRILL HOLE
DD-1 DEEP DRILL HOLE
TD-9 TAILING DRILL HOLE
PROPOSED GEOTECHNICAL DRILL HOLE
DH-6 DRILL HOLE
MAYFLOWER TAILING STUDY
DRILL HOLE LOCATION MAP
BINGHAM ENGINEERING
FIGURE 8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DH-1
SD-2
TD-8
SD-8
TAILING POND 3
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DH-12
DH-2
DH-9
DH-10
DH-17
DH-4
SD-3
DH-7
AILING POND 1
TD-9
SD-9
DH-6
6325
DH-13
DH-14
DH-3
DH-8
TAILING POND 2
6300
TD-10
SD-10
DH-15
DH-16
SD-1
DD-1 (OPTIONAL)
6350
EXPLORATION KEY
R-112 DRILL HOLE USBR (1982)
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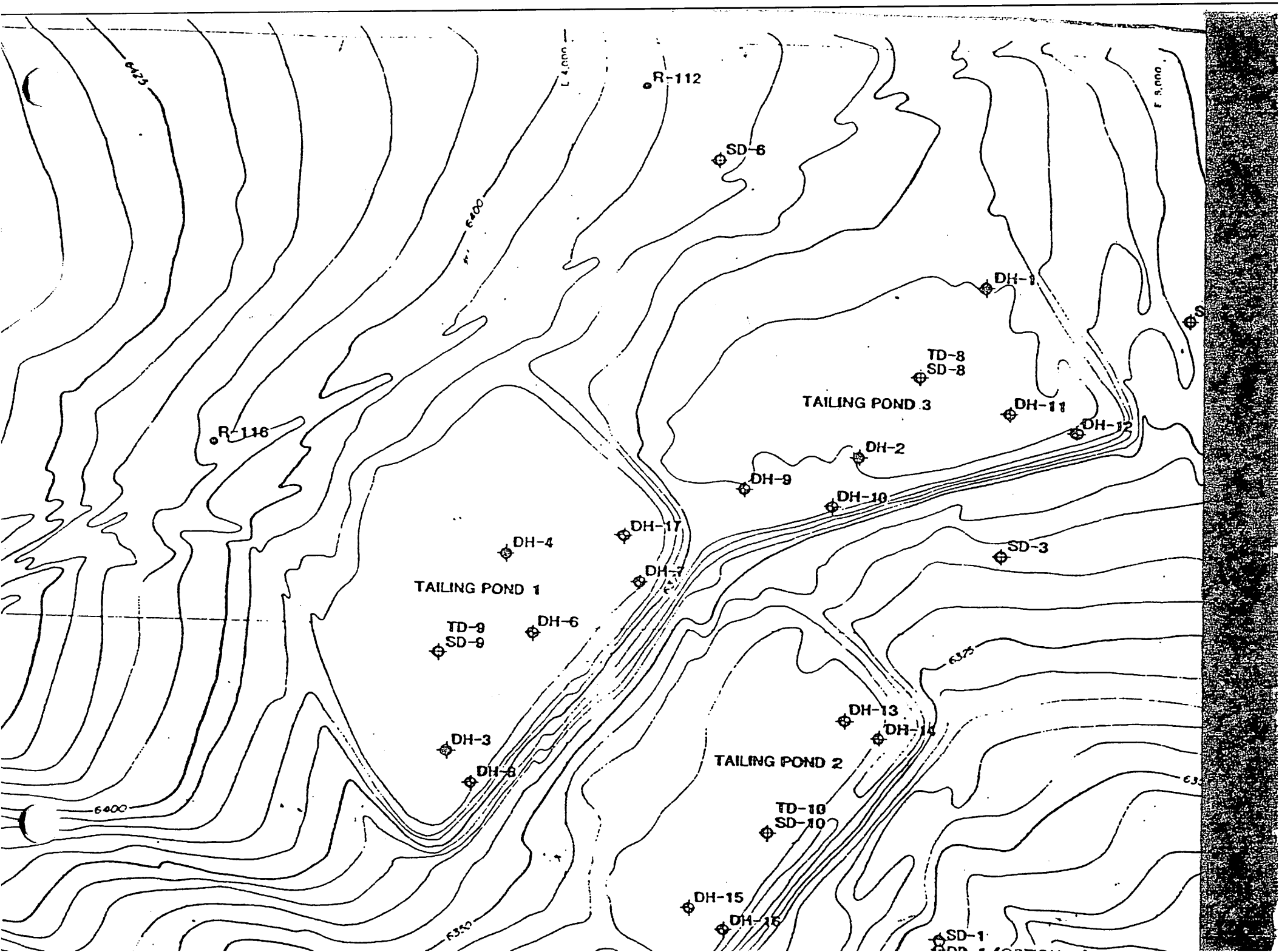
SD-1 SHALLOW DRILL HOLE
DD-1 DEEP DRILL HOLE
TD-9 TAILING DRILL HOLE
PROPOSED GEOTECHNICAL DRILL HOLE
DH-6 DRILL HOLE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SD-6
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6400
DH-1
TD-8
SD-8
TAILING POND 3
DH-11
DH-12
R-116
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DH-9
DH-10
DH-17
DH-4
SD-3
DH-7
TAILING POND 1
TD-9
SD-9
DH-6
6375
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DH-14
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DH-8
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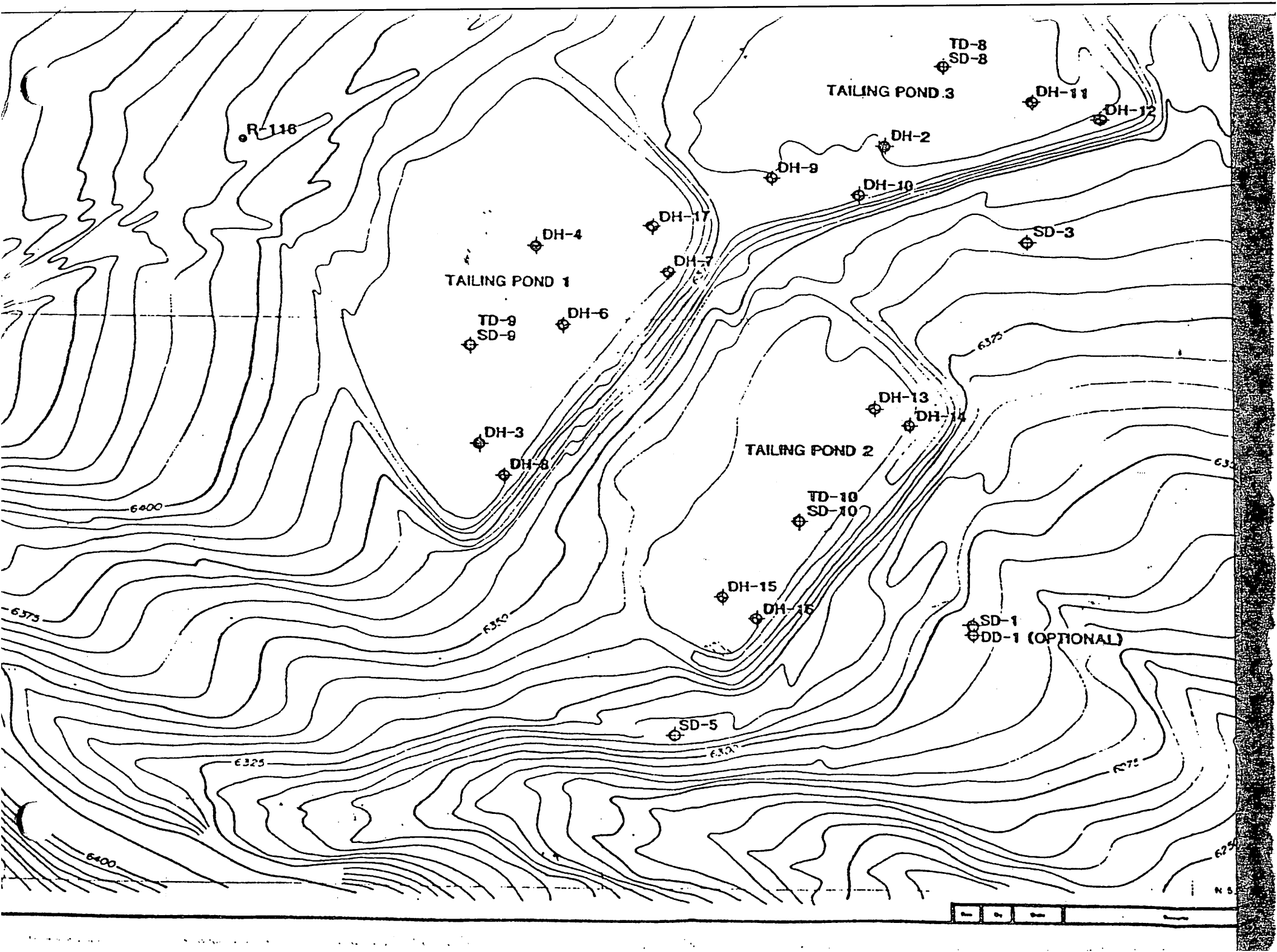
TD-10
SD-10
DH-15
DH-16
6350
SD-1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SD-8
TAILING POND 3
DH-11
DH-12
R-116
DH-2
DH-9
DH-10
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SD-3
DH-7
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TD-9
SD-9
DH-6
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DH-14
DH-3
TAILING POND 2
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SD-10
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DD-1 (OPTIONAL)
SD-5
6325
6400